ECONOMY AND ENVIRONMENT PROGRAM FOR SOUTHEAST ASIA

The Value of Improved Water Quality for Recreation in East Lake, Wuhan, China:

Application of Contingent Valuation and Travel Cost Methods

Du Yaping

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March, 1998

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Abstract

Improving lake water quality is believed to increase the economic value of recreational resorts. However, few empirical estimates have been made in China to determine the value of the economic benefits brought about by such improvements. In this study, two non-market valuation methods, contingent valuation (CV) and travel cost (TC), were used to gather empirical evidence on the economic value of improved recreational water quality. The values obtained from CV and TC methods were similar. Lake users were willing to pay for the use of the lake and its facilities, thus offsetting some of the cost of maintaining water quality for recreation. Payment for the improvement and maintenance of water quality could take the form of fees for entry, angling or swimming.

1.0 Introduction

East Lake (Donghu) is a highly appreciated recreational site, well known for its vast water surface area, natural tranquillity, and beauty within the metropolitan boundary of Wuhan. Each year, millions of visitors visit the lake area to enjoy recreational activities — most of which are directly related to water — boating, swimming, and angling.

If water quality was a marketable good, its value would be easily determined and realized in the market. But recreational uses of the lake are affected by changes in water quality. A hypothesis was made that improvement of water quality would lead to a higher demand for recreation in the lake with people willing to pay a higher price for better quality of environmental services. The outward shift of a demand curve would result in an addition to consumer surplus which might provide a good measurement of the value of improved water quality. Thus, the actual demand for recreational uses of the lake could be used as a surrogate market for change in water quality. Similarly, consumers' preferences for better quality could be revealed through their expression of willingness to pay. These two measurements could then be used to crosscheck the creditability of the value of improved water quality and provide a good indication of such value if the two measurements reinforce each other.

Initial analysis concentrated on pollution damages to recreational uses of the lake. Such examination looked at physical bases of the lake for recreational uses, existing uses for recreation, and pollution damages. Travel cost and contingent valuation methods were employed. Value estimation focused on the measurement of consumers' willingness to pay in relation to water quality improvement and the relationship between such values and socio-economic factors through regression analysis. A comparison of the results is made and conclusions are derived with respect to policy implications.

2.0 Pollution Damages to Recreational Uses

A total area of 73 km^2 around East Lake has been designated for recreational uses, 33 km^2 of which is covered by water with an average depth of 2.18 m. Major recreational uses of the lake area include sightseeing, jogging along the lake side, boating on the lake, swimming in the summer season, angling around the year, and water sports. The most frequent users of the lake are people who live around it. Occasional visitors come from areas farther away from the city.

In 1957, the lake was cut off from the Yangtze River. As more and more domestic sewage and industrial wastewater was discharged into the lake, water quality deteriorated. Daily discharge of wastewater into the lake was 180,000 tons in recent years. Each year, about 441 tons of nitrogen and 40 tons of phosphorus were added to the lake in net terms (HPIEP 1993). As a result, most parts of the lake have been assessed as eutrophicated water, unsuitable for drinking and many recreational purposes.

Due to water pollution, recreation has suffered serious damage and the most obvious has been to swimming. Three sites with swimming facilities have been closed, as they are located in the most polluted part of the lake. As a result, people have to travel farther away to find cleaner water that is in less safe areas and that is less enjoyable due to lack of facilities. The visual quality of water has reached such a low level that visitors may be disgruntled by the sight and smell of algae and dark water. In the 1950s, the lake water was clear, and on average, the naked eye could see past 2.8 m below the water's surface, in contrast to today's average of 0.6 m. In two heavily polluted parts of the lake, people could see past only 0.2 m (HPIE 1993). This has contributed to the downgrading of the lake's recreational value. Anglers must now travel far and experience difficulties in finding places suitable for fishing.

Little is known about the impact of pollution on recreational value. In this case, the number of paying visitors to the enclosed part of the lake area from 1949 to 1995 increased steadily until the middle 1980s. It then decreased and stabilized at around two million a year. A planning report (ISS 1992) suggests that major reasons for increase in visitor numbers are higher income and new recreational facilities. On the other hand, the decline is attributable to water pollution, lack of new recreational facilities, increase in entrance fee, impact of substitutes, and poor service.

Since the middle 1980s when water quality deterioration led to the closure of several popular swimming sites and was determined to be related to some health problems, implementation of cleanup programs has been slow for lack of investment and reliable estimates of the loss of values or damages due to pollution. In recent years, the media have stepped in and appealed for action against pollution. Although several plans have been made, their implementation is limited by the lack of funds for both investment and maintenance. Evidently, water quality improvement is, to a certain extent, a matter of economic viability, but few analyses have been made on the value of improved water quality in the lake. Although both CVM and TCM have been mainly applied in developed countries, researchers have undertaken studies in Thailand for the valuation of a national forest park using both methods (NREP et al. 1995) and for improved communal water services in Costa Rica and Laos (Aguilar and Sterner 1995). Their results show that both CVM and TCM studies can be of use in estimation of non-marketable environmental goods in developing countries.

3.0 Questionnaire Design, Sampling, and Survey Results

Given the controversy that shrouds the contingent valuation and travel cost method, much attention was paid to the survey instrument such that system errors and biases would be kept at a minimum through careful research design. In order to see whether the right questions were asked and the appropriate information was gathered for meaningful analysis, a pilot sampling was undertaken and two seminars were held to scrutinize the design and procedure. Preliminary analysis on the pilot study was reported by Du (1995). In this section, issues discussed include: designing of an interview schedule, sampling, conduct of interview, and results from the survey.

Questionnaire Design

Both TCM and CVM use a survey instrument to gather information from respondents on revealed preferences and contingent valuation. As water quality improvement for recreational uses is often regarded as a quasi-public good (Carson et al., 1996), the interview schedule was designed to verify that the respondents were consumers of such good. Specific consideration was given to information on status quo, water quality, details relevant to the derivation of travel cost, WTP questions, and socio-economic data of the respondents. (See Appendix A for a copy of the interview schedule.)

Several key issues regarding water quality are raised in the interview schedule. First, the respondents had their own judgments on quality levels based on their own observation. Thus, respondents' perception of water quality must be a determinant of their revealed preferences and contingent valuation. In this respect, the researcher considered the fact that any information on water quality might not be necessary.

Nevertheless, related information was provided as the interviewees were unlikely to have an overall picture of the water quality, its historical change, and the prospect of quality improvements. Because the lake was disconnected from the Yangtse River, water quality is now better in the inaccessible part of the lake (i.e., central area), than the accessible lakeside part which is visited by recreational users. The most polluted part of the lake is adjacent to the sewage outlet and has not been used for recreation uses since the late 1970s. Water in the enclosed recreation area has been polluted and its quality has been believed unsuitable for some recreation uses. Local users were well aware of such quality variations and visitors from far away could only, in most cases, experience first hand what the quality level was in the lake's recreational part. Thus, a sketchmap of quality grades in various parts of the lake was given as background information.

Quality improvement also requires specification. As consumers, respondents would be most interested in quality improvement in the traditionally accessible part of the lake, although the central part could be reached via the more expensive motor boats. It was made clear to the respondents that "improvement" referred to the accessible recreational part of the lake. There was also a question about the extent to which the improvement should be taken. The usual treatments include (1) movement from existing to a certain level of improvement (e.g., Choe et al 1996), and (2) movement from existing to different levels of improvement (e.g., Faber 1988, Carson and Mitchell 1993). The latter treatment was employed in this study as various standards were set by the state for different types of recreational uses. To make the water quality standards easily understood, they were simply related to suitability for various recreational uses. In this study, the description of water quality levels adopts those employed by Carson and Mitchell (1993), that is, boatable, swimmable, and drinkable. Fishable quality level is not listed as a separate entity as it is roughly the same as boatable.

Note that in Carson and Mitchell's study, no consideration is given to level of drinking quality. This was included in this study not because of the current commercial extraction of lake water for household consumption, but because the service sector in the lake uses lake water without much treatment for restaurants and hotels. This accounts for the demand for quality level water suitable for drinking by lakeside visitors. The question is not as incremental as that depicted in Carson and Mitchell (1993); rather it is stated as: "from existing to boatable, swimmable, and drinkable."

Because of the lake's location and travel constraints in China, visitor access to East Lake bears several specific characteristics. One is means of transport. In the studies by Farber (1988) and examples given in OECD (1989), means of transport is rather uniform; being either by private car or by plane. Such is not the case in this study. For one, few people in China own private cars. Moreover, the lake is located inside the city and many local visitors get there by bicycle or public transport (e.g., bus or taxi.) Those who live by the lake, simply walk. Furthermore, most group visits are organized and provided transport by sponsors such as conference organizers, trade unions, or youth organizations. For long distance travel, visitors have a choice of coach, train, passenger ship on the

Yangtse, or air. Thus, a specific question is included on means of transport for an estimate of travel time and cost.

A second question is about multi-purpose trips. Visitors from remote parts of Hubei Province and outside of Hubei come to Wuhan for business, reunions with relatives, or visits with friends. Even for tourists, East Lake is only one of several resorts they can choose from for their stay. This is why a multi-purpose question was asked to approximate travel cost to East Lake.

A third question is about the types of uses of the lake. It is used by swimers in the summer, frequent joggers or walkers around the lake, and boat lovers. This required the inclusion of a question on recreational use by types. WTP questions were organized so as to first ask if the respondent was willing or unwilling to pay for water quality improvement and then to ask the maximum amount he/she was willing to contribute to the lake cleanup project for various quality levels. Payment vehicle was supposed to be an increase in entrance fee and local taxation. The reasons for their refusal to pay needed to be asked and analyzed. Similarly, their reasons for willingness-to-pay were of interest to the investigation.

Finally, both TCM and CVM should be affected by respondents' social and economic conditions such as income, education, age, and sex. Such information is useful not only for a better understanding of the visitors' behavior, but also for projections of demand for water quality improvement. To determine the right income figure, complementary questions were included. This is because in China, payroll numbers do not represent real household income levels. Employees in the public sector may receive lower salaries than self-employed or company employees, but they enjoy more or less free medical care and housing allocation. As a result they may have a better economic standing. Thus, information on housing conditions was requested to adjust household income.

Sampling

It is important that for any meaningful analysis of survey data, the sample should be as representative as possible. While many prefer stratified sampling from the total population (e.g., Choe et al 1996, Hadker et al 1997), others use random samples from user groups only (e.g., Farber 1988). In this study, the survey concentrated on the users' group for a number of reasons. As mail or telephone survey proved unsuccessful in gathering correspondents' willingness to pay figures, it was anticipated that it would be difficult to obtain survey data from people outside Wuhan City. Visitors to the lake came from all over China and the proportion from different zones was consistent from year to year. Many visitor groups were not households or families, but friends or colleagues. Therefore, the users' group was believed representative of the general population. Thus, individual visitors instead of households were chosen as respondents for interview. "Visitor" was broadly defined as those who use the lake for recreation. This meant that

people who lived by the lake must be counted as visitors if they take a walk or cycle around the lake for relaxation. However, passersby, employees in the administrative and services sector of the lake area, and those in the area for business purposes were not counted. The visitors were randomly chosen for the interviews that completed the questionnaire. Also, the sampling was arranged to reflect changes in seasonal uses of the lake (70% in spring and autumn, 25% in summer, and 5% in winter).

Four postgraduates were trained to undertake the survey. Each of the trained interviewers was responsible for one or two locations where he/she distributed the questionnaire to respondents and offered explanations and assistance in completing the questionnaire. The presence of an interviewer was considered necessary to ensure a proper completion of the survey sheet and a high return rate.

Overall Features of the Sample

In total, 600 copies of the questionnaire were prepared and distributed by interviewers. Of the 501 questionnaires returned, 408 could be used for TCM and CVM analyses. Of 93 invalid replies, 21 answered with don't knows, 40 did not complete the questions (including 7 with illegible responses), 6 were considered inconsistent because their WTP figures exceeded 5% of household income, and 27 were either employees in the administration or service sector of the lake area involved in the survey. This sample size is not large when compared with the national scale survey by Carson and Mitchell (1993), whose study reported a total of 813 interviews, with 564 usable ones, for estimating the value of clean water all over the United States. Considering the somewhat localized nature of the survey and sampling techniques, this sample number may provide a sound basis for estimates of the demand for recreational uses and WTP figures at a statistically significant level. Statistical values of the variables are summarized in Table 1.

Survey results show that over 50% of the respondents visited occasionally; and 16.7% visited only once in a year or once in a lifetime (visitors from outside Hubei Province). The major purpose of repeat visitors was walking, jogging, swimming or boating activities, which were either highly localized or seasonally concentrated. Due to the highly frequent visits by locals, the sample mean of 21 may be an overestimate. The median number of 4 may be more representative of an average visitor (Table 1).

Among 148 visitors from outside Wuhan, 87 were in Wuhan for business, 29 to visit friends or relatives. Only 26 were actually tourists, the others were there for various other purposes. Less than 5% of the visitors considered water quality good, in contrast to nearly 60% who believed it bad or very bad, with about 30% believing the water to be tolerable or answering with don't knows. These figures demonstrate that majority of the visitors were unhappy with the water quality. Visitors' judgment on water quality seems to have some impact on their willingness or unwillingness to pay. Among the 80 refusals-to-pay, 55 considered quality level tolerable or good. This corresponded to the reasons

Table 1. Statistical Values of Variables

Vartiable	Mean	Std Dev	Median	Minimum	Maximum
No. of visits					
E-level (Existing quality)	21.78	49.34	4.0	1.00	301.00
B-level (Suitable for boating)	23.84	52.75	5.0	1.00	320.00
S-level (Suitable for swim.)	26.91	54.89	7.0	1.00	330.00
D-level (Suitable for drinking)	31.14	60.49	9.5	1.00	350.00
Distance (Km)	89.30	176.35	9.0	1.50	600.00
TC (full wage)	80.16	78.81	42.4	12.70	267.60
TC (1/3 wage)	75.78	75.57	39.6	11.50	255.20
Self judgement on WQ					
(on a 1-5 scale - 1: polluted; 5: clean)	2.28	0.83	2.0	1.00	5.00
Income (Y/c/m)	407.34	123.20	450	130.00	570.00
Housing (ownership)	1.20	0.10	1.2	1.00	1.40
House (rooms)	1.21	0.88	1.2	1.00	1.4
Education (Schooling years)	13.01	3.84	16.0	0	19.00
Age (ys)	37.95	11.59	37.0	18.00	67.00
Sex (m = 1; f = 0)	0.73	0.45	1.0	0	1.00
WTP-D (Y/a/c)	27.46	32.24	20.0	0	200.00
WTP-S (Y/a/c)	18.14	24.41	10.0	0	250.00
WTP-B (Y/a/c)	10.26	13.88	5.0	0	100.00
WTP: y/n (y = 1; n = 0)	0.81	0.40	1.0	0	1.00

Note: Water quality levels: D= drinkable, S= swimmable, B= boatable/fishable, E= existing level; TV= travel cost; WQ= water quality: y/c/m= yuan per capita per calendar month, ys= years, y/a/c= yuan per annum per capita; Ownership: rented = 1.0, shared= 1.1, long lease= 1.2, partially owned= 1.3, fully owned= 1.4, House: shared room= 1.0, one room= 1.1, two rooms= 1.2, three rooms= 1.3, four or more rooms= 1.4.

given by the refusals, 29 cited quality as okay and 21 indicated income too-low-to-pay. Free riders who regarded quality improvement "not my business" accounted for 35% of the total refusals. About 74% of the refusals were occasional users. If the above two features are self-explanatory, it is somewhat hard to understand that over 2/3 of the refusals were from relatively high-income households. With respect to sex, only 15% of the refusals were female, compared with 27.2% women in the sample total.

A look at the social and economic features of the sample reveals several observations. Most visitors were from relatively high-income families, with an average figure of RMB ¥407 per capita per month. This is understandable as travel is considered a luxurious good and only the rich are able to materialize their demand for recreation. About 50% of the respondents lived in partially owned two-bedroom flats. Such condition is consistent with the overall pattern of urban housing in China. The schooling years of the visitors were higher than the national average (13 years), and over half had some higher education.

The age structure suggests that over 90% of the visitors fall in the working age group. No specific attention was given to sex in the survey, but 2/3 of the respondents were male. It is normally the case that male visitors outnumber females in most travel groups. This may be the case particularly in summer when few females join the swimmers' group.

4.0 Analyses: Travel Cost Vs. Contingent Valuation

Demand for Recreation

The surrounding area of the lake is divided into zones of increasing distance. Considering the road system and population statistics, spatial division is made in accordance with administrative areas, including 8 urban districts (3 inner most zones) and 6 suburban counties (4th zone) in Wuhan, 5 cities and prefectures of Hubei Province surrounding Wuhan (5th zone), 4 remote prefectures of Hubei Province (6th zone), and other parts of China (7th zone).

Based on the visitors' report on means of transport, four types of transport for short distance travel were used: (1) bicycle, (2) bus, (3) taxi, (4) private, business or government car. Business and government cars were treated as being equivalent to taxi in the calculation of travel time and travel cost. As no information was given by visitors on means for long distance travel, local statistics on passenger turnover was used to derive the proportion of travels by air, train, river, and coach, and weighted averages were calculated for travel cost and time for each zone.

The value of travel time used to calculate the price of a trip is controversial. Some (e.g., OECD 1989) have suggested using full hourly wage as a measure of the value of recreational travel time, although the after tax rate is used. Some estimates approximate the value to be one-third the full wage rate or 10% of the wage (Farber 1988). In this application, the value of travel time employed two levels: full and one-third the hourly wage. This was due to two facts: that the wage rates received by most employees in China were below the taxable income level[1], and that relaxation through recreation was not very much frequent. Calculation of wage rate was based on average income per urban employee, which was approximately RMB ¥3/hr as full wage rate[2]. Since differential change of wage rate did not have much impact on travel cost, in the demand analysis,

[1] In China, the taxable income level was RMB ¥800 per month and the average income level in Wuhan was less than RMB ¥500 in 1995. Before 1978 when economic reform was initiated, no personal income tax was levied as the Government kept a policy of low disposal income and relatively free allocation of public goods (e.g., education, and highly subsidized provision of social security via government programs such as free medical care and housing)

[2] The annual earning of an employee in Wuhan was RMB ¥6500 in 1996 (RMB ¥541 per month, RMB ¥25 per workday and RMB ¥3.1 per hour). Farmers' income was on average half of the urban employees but food in rural areas is normally self-reliant.

only full wage rate was employed for illustration. Total travel costs by zones are given in Table 2. They consist of three components: cost of transport, time cost, and other expenses. For multipurpose visitors from Zone 4 and outwards, 30% of the long distance cost is accrued to the cost of a visit to East Lake. Time costs for long distance travel were treated in a similar manner. However, visitors from farther than Zone 5 had to stay overnight if they wished to visit East lake. Therefore, there is a need to add the cost of lodging.

Table 2. Total Travel Cost (RMB ¥)

Zone	Transport	Time Cost		Other Cost	Total (ex landing)		Landing	Total	
		full-wage	1/3 wage		full-wage	1/3 wage		full wage	1/3wage
1	1.6	1.8	0.6	9.3	12.7	11.5		12.7	11.5
2	11.4	4.2	1.4	26.8	42.4	39.6		42.4	39.6
3	21.6	6.6	2.2	30.7	58.9	54.5		58.9	54.5
4	37.6	9.6	3.2	25.5	72.7	66.3		72.7	66.3
5	51.2	9.6	3.2	30.9	91.7	85.3	50.0	141.7	135.3
6	62.8	10.8	3.6	24.5	98.7	90.9	100.0	198.7	190.9
7	123.0	18.6	6.2	26.0	167.6	155.2	100.0	267.6	255.2

Note: full wage = full wage rate, at RMB ¥3/hour;
1/3 wage = one third wage rate, at RMB ¥1/hour.

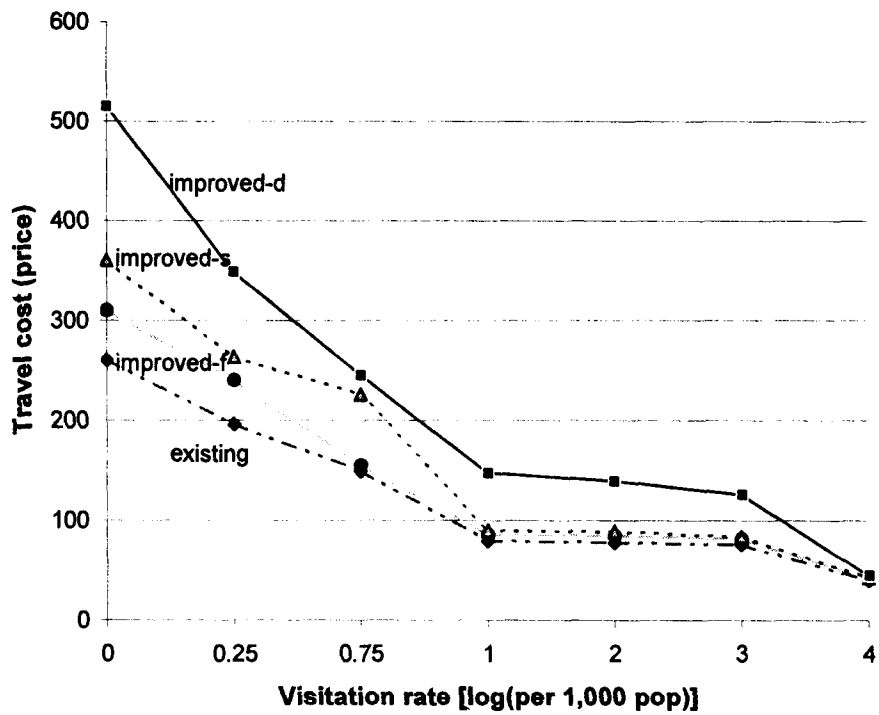
Visitation Rate and Demand Curve

Visitation rates for individual zones were calculated by dividing the yearly visits by total population in the same zone. As distance increases, the visitation rates decrease drastically from 8,756 per 1,000 population in the innermost zone to 0.05 per 1,000 population in the outmost zone. Similarly visitation rates were derived for improved water quality levels. Using the data of visitation rate and the total travel cost at full wage rate, a demand curve was constructed (Figure 1). Travel cost or price for recreation per visit is depicted on the vertical axis while the quantities of demand are on the horizontal axis. As the demand is very price elastic, the scale of quantities is transformed logarithmically so that the relationship between high cost and low demand is shown clearly.

In Figure 1, it is rather clear that visitors enjoyed considerable consumer surplus from their recreational activities. As water quality improves, the demand curve moves outwards and the amount of consumer surplus is increased. Using the linearly connected

points, the amount of consumer surpluses were obtained and presented in the first 2 columns of Table 6. Under existing water quality level, annual total of consumer surplus amounts to RMB ¥141.62 million. An additional 15.01 million would be gained if quality level increased from existing to boatable/fishable. If water quality is further improved to swimmable and drinkable, the total consumer surplus would increase to RMB ¥180.11 and RMB ¥209.98 million respectively.

Figure 1. Visitors' demand curves for the East Lake.



Using visitation rate as a dependent variable and travel cost as an independent variable, two types of regression analyses were undertaken to find the best fit functional form between the two. The first type of function is a semi-logarithmic form ln(VISITS) = $\alpha + \beta$ (COST) where VISITS is visitation rate in terms of numbers per thousand population and COST is the travel cost, for one visit:

$$\ln (\text{VISITS}) = 8.974627 - 0.047344\ (\text{COST})$$
$$(0.0654) \qquad (0.0006)$$

$$r^2 = 0.9422$$

This demand function was regressed for existing water quality. Figures in parentheses are standard errors. The correlation shown in the above equation is significant at 99%. The coefficients (β) values for boatable, swimmable, and drinkable water qualities are rather close while the intercepts (α) for each function vary significantly, being 8.975, 9.096, 9.260, and 9.384 for visitation rates under existing, boatable/fishable, swimmable, and drinkable quality levels, respectively.

Quadratic form was also used for the same set of data. The correlation is, however, not good as in the semi-log form. The parameters for existing water quality level are shown below:

$$\begin{array}{lcccccc} \text{VISITS} & = & 8208.70 & - & 126.93(\text{COST}) & + & 0.3755(\text{COST})^2 \\ & & (202.21) & & (4.83) & & (0.018) \end{array}$$

$$r^2 = 0.6985$$

Like before, figures in parentheses are standard errors. Parameters for other quality levels show a similar pattern and are not further examined here.

Multivariate analysis was carried out to see if other factors affected demand. Functional form is semilog (i.e., visitation rate in logarithmic form) while dependent variables are in actual numbers. The results shown in Table 3 are rather similar to the semi-log demand functions discussed earlier. Travel cost is a major determinant for the change in demand. It is significant at 99%, while all other factors including income, education, and judgment of water quality, do not seem to be a major factor affecting demand at 95% significance level. Income is inversely related to demand. This result is similar to the findings of

Table 3. Factors Affecting Demand: Multivariate Analysis

Variable	Prob>|t|	Existing	Boatable	Swimmable	Drinkable
Intercept	0.0001	9.1022	9.2054	9.3664	9.4668
Travel cost	0.0001	-0.0468	-0.0466	-0.0464	-0.0458
Income	0.07-0.11	-0.0005	-0.0005	-0.0004	-0.0004
Education	0.04-0.06	0.0242	0.0249	0.0227	0.0243
Judge. WQ	0.09-0.10	-0.1013	-0.1048	-0.0977	-0.1016

Farber (1988) who concluded that wetland use is an inferior good. However, this conclusion may not be compatible with the case in China where outdoor recreation is still regarded by some to be a luxury good. The reason for such an inverse relationship may be largely a result of a large number of local visitors who use the lake frequently but whose demand for recreation in the lake is somewhat irrelevant to income due to the short distance.

Contingent Valuation Analysis

Average WTP figures are given in Table 4 together with statistical description of the sample. Overall it is clear that better quality attracts a higher amount of WTP. In general, the medians are lower than the arithmetic means, indicating that more visitors yielded WTP lower than the average. In order to see the influences of visitors' specific background or information on WTP, the following examination is made with respect to WTP at quality level suitable for swimming.

No overall linear relationship can be observed between the frequency of visits and WTP bids. However, there seems to be a trend where less frequent visitors (less than 4 times a year) were willing to pay less than the sample mean while more frequent visitors (over 20 times a year) yielded higher figures than the sample mean. Similar to the case of frequency of visits, the grouped averages from shared to most spacious housing do not show straight linear relationship since the mean for the shared group is higher than for those with one-bedroom flat. For all other groups, there is a clear indication that respondents with better housing were willing to pay more. The complication in the case of shared housing respondents may be explained by the possibility that respondents in this group actually share large housing with their parents, which can be better than one bed-room flats. The relationship between WTPs and distances present an irregular pattern and WTP with visitors' judgment on quality, income, and education show a rather well-fitted linear relationship. Housing ownership, sex, and reasons for willingness to pay seem to have no impact on WTP amounts. With respect to sex, for instance, the WTP for swimmable quality are 17.6 and 18.4 for female and male respondents respectively, a difference of less than 5%. In addition, seasonal variations were also observed in WTP figures. In chilly winter when water related recreational activities are not as enjoyable, respondents yielded lower WTP figures than they did in other seasons. The difference in WTP between hot summer, mild spring, and autumn is not very large, with WTP during summer being relatively higher.

Based on the results from the above examination, income, housing, and education are highly correlated with WTP figures, and visitors' judgment on water quality has a certain degree of correlation. As housing is considered a complementary factor to income, it should not be used as an independent variable in the regression analysis. In order that housing conditions are reflected, it is used to adjust income for better representation of

respondents' income levels. Such adjustment was made by increasing income levels by 10% for each additional room. Although as shown in the above analysis, the travel distances are not well correlated to WTP bids, it is still included in the multivariate regression model to see if it could exert any statistically significant impact on WTPs.

The functional form of the regression model is as follows:

$$WTP = (\alpha 0 + \alpha 1(\text{income}) + \alpha 2(\text{education}) + \alpha 3\ (\text{travel distance}) + \alpha 4\ (\text{judgment on water quality})$$

Table 4. Multivariate Regression: WTP for Improved Water Quality up to Various Levels

Variable	Parameter	S Error	T for H_0: Parameter=0	Prob > |T|
Suitable for boating (F=13.397; Prob >F: 0.0001; R-square: 0.1181)				
INTERCEPT	-5.2333	3.4409	-1.521	0.1291
INCOME	0.0197	0.0040	4.935	0.0001
EDUCATION	0.6345	0.1792	3.541	0.0004
DISTANCE	-0.3978	0.3559	-1.118	0.2644
PERCEPTION	-0.5648	0.7055	-0.801	0.4238
Suitable for swimming (F=15.393; Prob >F: 0.0001; R-square: 0.1334)				
INTERCEPT	-7.9098	6.0136	-1.315	0.1892
INCOME	0.0333	0.0070	4.764	0.0001
EDUCATION	1.2499	0.3132	3.991	0.0001
DISTANCE	-0.9588	0.6221	-1.541	0.1240
PERCEPTION	-1.5866	1.2330	-1.287	0.1989
Suitable for swimming (F=14.777; Prob >F: 0.0001; R-square: 0.1278)				
INTERCEPT	-10.0588	7.9615	-1.263	0.2072
INCOME	0.0419	0.0093	4.527	0.0001
EDUCATION	1.7869	0.4146	4.310	0.0001
DISTANCE	-1.2723	0.8236	-1.545	0.1232
PERCEPTION	-1.0660	1.6324	-0.653	0.5141

Note: Income was adjusted to reflect housing conditions.

Table 4 presents the parameters and statistics of the WTP model for improved water quality. The model with four variables on the whole had an F value of 15.393 for swimmable quality level and was significant at the 99% level. If the explanatory variables are looked at individually, income and education were significant variables at the 99% level while intercept, distance, and perception did not seem to be of statistical significance. This suggests that there existed a large variation in intercept value and that the other two variables were not well related to the dependent variable. The adjusted income slightly improved the model as the r^2 was marginally higher than that without income adjustment. Even with the adjustment, however, the r^2 was still very low, being only 0.1334. With such a low r^2, the model is unlikely to estimate reliable WTP figures with a given set of socio-economic data. Nonetheless, the parameters of the model are rather indicative of the overall behavior of a respondent against his or her socio-economic background.

5.0 Comparison of the Values From TCM & CVM

Total Consumer Surplus as Derived from TCM

Under existing water quality, total consumer surplus as measured from travel cost amounted to RMB ¥41.62 million per annum. Using a discount rate of 8%, the present value of consumer surplus was RMB ¥1,911.9 million. If the discount rate is 3%, the present value of the recreational lake area reaches as high as RMB ¥4,862.3 million. This means that the unit value of the lake area (73 km^2) is about Y26.6/m^2 at discount rate of 8% and Y66.6/m^2 at 3%. Such value is 10-30 times the compulsory purchasing price of agricultural land for nonagricultural uses, higher than the commercial land price in small and medium cities though not as high as that in Wuhan.

If water quality is to improve, total consumer surplus will increase accordingly (Table 5). When boatable water quality is guaranteed, consumer surplus would increase by RMB ¥15.01 million annually, or a total of RMB ¥202.6 million at a discount rate of 8% or RMB ¥515.3 million at 3%. At a discount rate of 3%, the net addition of consumer surplus due to quality improvement would be RMB ¥18.09/m^2 at swimmable quality level and RMB ¥32.13/m^2 at drinkable level. This shows that consumer surplus is likely to double through water quality improvement if a lower discount rate of 3% is adopted.

Total Benefit as Revealed by CVM

The aggregate WTP for the total population was computed. As there exist multiple visit makers, the number of visits as used in the travel cost calculation is likely to overstate WTP aggregate. People in Zones 1 and 2 must be counted as part of the target population as they are the most frequent users (total 1.711 million). People in Zones 3 to 7 constitute 20% of the total visits and their frequency of visits is assumed to be twice a year, based on

the data from the lake administration. This gives a figure of 0.8 million visitors from Zone 3 outwards. Adding these two together, the target population is taken as 2.511 million.

The annual total WTP as measured by CVM and total present value at discount rates 8% and 3% are presented in Table 6. At the lower rate of discount at 3%, total WTP per square meter in the recreational area is RMB ¥12.11, RMB ¥21.41, and RMB ¥32.41 if water becomes clean enough for boating, swimming, and drinking, respectively.

Table 5. Consumer Surplus from Recreational Use of East Lake (1996 value, million RMB ¥)

Quality	Value/yr.		Total Value			
	Total	Increment	Total	Increment	Total	Increment
			Discounted at 8%		*Discounted at 3%*	
Existing	141.62	0	1911.9	0	4862.3	0
Boatable	156.65	15.01	2114.5	202.6	5377.6	515.3
Swimmable	180.11	38.49	2431.5	519.6	6183.8	1321.4
Drinkable	209.98	68.36	2834.7	922.9	7209.3	2346.9

Table 6. Total Benefit as Measured by CVM

Quality	Average y/a/c	Aggregate Million/y	Present Value (million) d = 8%	d = 3%
Boatable	10.26	25.76	347.76	884.43
Swimmable	18.14	45.55	614.93	1563.88
Drinkable	27.46	68.95	930.83	2367.28

Cross-check of TCM and CVM Values

When comparing CV and TC results, Tables 5 and 6 indicate that CV values are higher than those from travel cost. In terms of annual value, CV estimate is 71.62% higher than travel cost measurement when water quality is improved from existing to boatable level. If water quality is further improved to swimmable level, the revealed WTP by respondents is 7.06 million more a year than visitors' consumer surplus. However, CV figures do not seem much higher than those of consumer surplus at drinking quality level, being only 0.86% higher. The difference may be reasonably taken as existence value of the lake for recreation. To many respondents, swimmable quality is the maximum level for their moral commitment, and the level of drinking quality may be unnecessary.

Travel cost values the utility a visitor enjoys at the recreational site. In practice, consumer surplus as measured under the demand curve for recreation by visitors consists of use value only. Perhaps some indirect use values such as local micro-climate may be taken into account by visitors. However, non-use values such as option value as a future use value element seem to be irrelevant here as visitors did not consider use options other than recreation. The element of existence value of the lake is unlikely to be included in the travel cost measurement because visitors are interested in or consume recreation in the lake area. If the lake ceased to exist, visitors would not go and what they lose is their consumer surplus.

By contrast, CV measurement does not exclude non-use values. There is a question in the questionnaire regarding the reasons why the respondents were willing to pay. The information obtained through this question may be seen as evidence for this statement. According to the answers, only one in three considered the payment for their own sake, as compared to over 40% who paid because of a sense of social responsibility, and about 16% who were willing to the benefit of future generations. The rest of the respondents cited a combination of two or three of the reasons mentioned above. Such answers indicate that respondents were willing to pay not only for their own consumption, but also for other reasons unrelated to their own recreational uses of the lake. Clearly, the existence of the lake with better water quality is valued here as part of social responsibility.

6.0 Conclusions And Suggestions

Concluding Remarks

From the travel cost investigation, it has been demonstrated that improved water quality shifted the demand curve outward. There is little difference in the curvature of the demand function. The main change is the outward movement of intercept when quality improves. The CV estimates have revealed a similar trend. But such measures

are higher than the values estimated through travel cost. This difference may lie in the inclusion of an existence value in the contingent valuation measurement as travel cost largely reveals the use value of a recreational site as a consumption good.

Except for recreational uses, the lake has served other purposes such as fish farming and water supply. Such values were not reflected in either travel cost measurements or CV values. There is reason to believe therefore that both estimates understate the true use value of the lake. Nevertheless, non-recreational use values could diminish as the potential of the lake for its recreation value is further explored and marketed. Contingent valuation was independent of travel cost and the number of visits a respondent actually made. It was heavily dependent on income, education, and the judgment of respondents on water quality in the lake. Age and sex did not seem to have much impact on contingent valuation.

Methodological Implications

The results from travel cost method and contingent valuation reinforce each other. This implies that when a questionnaire is carefully designed and a survey correctly conducted, both CVM and TCM can be used to derive the values of an unpriced environmental good such as water quality improvement. However, there are some complications. As the recreation site is well located in the urban area, the means of transport and cost of travel vary greatly. In a developing country like China where private cars are not the major means of transport, questions on and analysis of transport must be given specific consideration. Also, treatment of time is rather tricky in two aspects: wage rate and multipurpose travel. In comparison with transport and other direct expenses, time cost can be insignificant as wage rate was low and time cost of long distance travel was shared with other purposes. These two case-specific features are unique to this study as they are different from many other existing TCM studies conducted in developed countries.

Policy Implications

With the positive recreation value of improved water quality derived in this study, it is rather clear that there is a welfare loss to consumers from lake pollution. From the 1960s (pre-pollution period) onwards, one-third of recreation value of the lake has been lost due to pollution. Water quality improvement from the status quo would increase the recreation value of the lake by 50% of its annual value! This indicates that water pollution treatment measures should be taken to clean the lake, but it may not be worthwhile to pursue attainment of the highest drinkable quality level.

Policies or measures must be taken to discourage free riders and to elicit payment for better quality. It is probably impractical to collect such payments through local taxation or donations, but they could be collected without excessive administrative cost through fees for entry, angling or swimming.

Limitations of the Study

Caution must be taken in interpreting and using the results from this study. Since demand is contingent on real improvements in water quality, there might be a difference between hypothetical and real situations. Moreover, because many visitors from far away normally do not come to Wuhan only for recreation in the lake, additional effort may be required to proportionate time and cost to the price for demand analysis. Finally, the value estimated in this study is that of improved water quality for recreation only. Water quality may have other benefits such as health benefits and productive uses of the water.

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APPENDIX A: QUESTIONNAIRE

QUESTIONNAIRE ON WATER QUALITY IMPROVEMENT OF EAST LAKE, WUHAN

East Lake is one of the most famous scenery areas in China. Every year, millions of visitors come to the lake for enjoyment and relaxation. As a consumer, you may use the lake for sightseeing, swimming, boating, and other water sports like water skiing, angling, walking, or cycling. East Lake is also used for fish farming and plays an important role in supply of water for industrial and domestic consumption.

According to environmental scientists, water quality of the lake needs to be improved to meet consumers' demand. As you may have noticed, the lake's water quality may not be everything you expected. In fact, many parts of the lake previously used for swimming had to be closed because of pollution. Therefore, environmental planners have worked out an ambitious project to improve water quality in East Lake, but money is required to implement the plan.

This survey aims to obtain information from lake visitors and local residents on uses of the lake and their opinions about the water quality. It is essential that we obtain accurate information from your responses. Please tick the appropriate boxes to indicate your choices. Thank you for your cooperation.

East Lake consists of 8 sublakes, with water surface area of 33 km^2. See the attached sketch map showing the lake area and water quality in sublakes.

1. How many trips have you made to East Lake within the last 12 months for purposes of

Sightseeing and Recreation	___	Swimming	___
Boating	___	Angling	___
Exercising	___	Others (specify)	___
Total	___		

2. Where do you live?

District_____	of Wuhan	County _____	of Wuhan
County _____	Prefecture_____	Province_____	Country _____

3. If you were not on this trip today, what would you most likely be doing ?

___ Working at job ___ Watching TV
___ Housework or shopping ___ Other:_____

4. How many hours were you at the Lake today? ___hours

5. How did you get here?

___ By bicycle ___ By bus ___ By motorcycle
___ By taxi ___ By private car
___ Other (please specify):_____

6. Please estimate what it costs you today in total _____
and by item for

Entrance ticket _____ Food & beverage _____
Sight-seeing & recreating _____ Photographs _____
Other _____

7. Please estimate the time and distance it takes you to get to the lake from your home?

_____hours _____kilometers

8. If you are not from Wuhan, you came to Wuhan for

___ Conference attendance ___ Business
___ Visiting friends or relatives ___ Travel
___ Other:_____

9. How would you describe the water quality of East lake?

___ Very poor ___ Good
___ Poor ___ Excellent
___ Fair ___ Don't know/not sure

Perhaps you may want to know if there are any planned treatment projects for water quality improvement of the lake. The answer is yes. The project involves construction of miles of wastewater collection channels (pipes), three treatment plants with a daily capacity of 300,000 tons, and introduction of river water from the Yangtze to change the lake water. With the implementation of the project, water quality in majority of the sublakes will meet the quality level of Grand II of the national water quality standard. In other words, it will be suitable for use as source for drinking water supply (see the attached sketch map).

As 90% of wastewater is domestic sewage, the cost of the project, or at least the running cost, will be shared among domestic and industrial users (including visitors), through payment of discharge fee. Such fees may be collected through higher entrance charge, increase in water price and/or community charge.

10. Suppose there was an opinion poll next Monday to determine whether the treatment plan should be put into operation. Assume you have only one vote, please indicate which choice you prefer:

___ Choice A: Pay no money but do not treat water in East Lake even if it means letting water quality deteriorate.

___ Choice B: Pay a certain amount of money each year and have water quality improved and maintained up to certain accepted levels.

For the expected water quality levels as described below, the maximum amount would be

___ Drinkable _____Yuan/year
___ Swimmable _____Yuan/year
___ Boatable/fishable _____Yuan/year

11. If you chose A in question 10, why?

___ The water quality is all right, not necessary to improve
___ No money to pay because of my low income
___ Not my responsibility
___ Others (please specify):

12. If you chose B in question 10, for whom is the improvement in water quality for?

___ Yourself (a nice environment when you visit)
___ Society at large (a social responsibility)
___ Future generations (should not be deprived of clean water)
___ Others (please specify):

13. If water quality is improved in the near future, perhaps you may wish to come to the Lake and spend more time for recreation. Depending on the water quality level, how many more times would you be here?

Quality level	Visits/Year
Boatable/fishable	_____
Swimmable	_____
Drinkable	_____

To help us analyze the results, we would like to have the following information.

14. What is the approximate average monthly income per capita of your household ?

___ Less than 150
___ 150-180
___ 180-220
___ 220-260
___ 260-320
___ 320-380
___ 380-520
___ More than 520

15. What housing do you live in?

___ 4- or more bedroom flat
___ 3- bedroom flat
___ Shared room
___ 2- bedroom flat
___ 1- bedroom flat

16. What is the tenancy status of your residence?

___ Bought with full ownership
___ Long lease without ownership
___ Shared with parents or friends
___ Bought with partial ownership
___ Rented

17. Your education

___ Illiterate
___ Primary school
___ Secondary school
___ University
___ Post graduate

18. Your age _____ years

19. Your sex

___ Male ___ Female

Thank you for sparing your time to answer this questionnaire. If you have any comments or suggestions about the water quality treatment of East Lake, we would be interested in knowing them.

_____
_____
_____
_____

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